European Journal of Orthodontics, 2016, 286–291
doi:10.1093/ejo/cjv042
Advance Access publication 1 July 2015

Original Article

No association between gingival labial recession and facial type

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Summary

Objective: To evaluate if facial type is a predictor of the development of gingival recession.

Methods: A cohort of 179 orthodontic patients (76 males, 101 females; age before treatment T_S = 12.4 years, SD = 0.8) were followed until 5 years post-treatment (T_5 = 20.7 years, SD = 1.2). The presence of recessions was scored ('Yes' or 'No') by two raters on initial (T_S), end of treatment (T_0), and post-treatment (T_5) plaster models. A recession was noted (scored 'Yes') if the labial cemento-enamel junction was exposed. The clinical crown heights were measured at T_S, T_0, and T_5 as the distances between the incisal edges and the deepest points of the curvature of the vestibulo-gingival margins. Determination of the facial type was based on the inclination of mandibular plane relative to cranial base (Sella-Nasion/Mandibular Plane) and the proportion of posterior to anterior face heights (PFHs; SGo/NMe × 100 per cent) on pre-treatment cephalograms.

Results: From T_0 to T_5, the number of subjects with recessions increased from 2 (1.1 per cent) to 24 (13.6 per cent), and the number of recession sites increased from 2 to 39. However, most patients had either one or two recession sites. The mean clinical crown height of mandibular incisors increased by 0.86 mm (SD = 0.82, $P < 0.001$). Regression analysis showed that mandibular plane inclination had no effect on the development of gingival recession or on the increase of clinical crown heights of mandibular incisors.

Conclusions: Facial type is not a predictor of the occurrence of gingival recession.

Introduction

The development of gingival recession can be linked to previous orthodontic treatment (1, 2). Slutzkey and Levin (1) found that the proportion of young adults (18– 22 years of age) with recessions was more than twice as high in subjects who were treated orthodontically in the past (23 per cent) than in those who were not treated orthodontically (11 per cent). Also Renkema *et al.* (2) found that labial gingival recession is more prevalent in orthodontic patients than in untreated orthodontically subjects and the odds ratio to have recession is almost 4.5 for orthodontic patients as compared with controls. The authors also found that mandibular incisors are relatively most vulnerable to the development of gingival recession. Recessions are unesthetic, easily noticeable by the patient, and can cause discomfort. Therefore in a case of severe recession the risk of orthodontic malpractice litigation is increased (3).

The aetiology of gingival recession, particularly the role of mandibular incisor inclination, is not clear. Early animal experiments (4, 5) indicated that significant anterior movement of lower incisors resulted in alveolar bone loss and could lead to gingival recession. Batenhorst *et al.* (4) found that aggressive incisor proclination followed by a phase of spontaneous extrusion caused apical migration of epithelial attachment on the labial aspect of proclined teeth in Rhesus monkeys. This was accompanied by formation of alveolar dehiscences. Steiner *et al.* (5) reported similar findings—loss of marginal bone, loss of connective tissue attachment, and ensuing gingival recession—following labial incisor displacement also in monkeys. Clinical studies, in turn, provided equivocal evidence for the relationship between incisor position and gingival recession—some showed that such a relationship, although weak and probably clinically irrelevant, exist (6, 7), while others did not confirm this association (8, 9). None of these studies considered, however, that the proclination of mandibular incisors in subjects with thin alveolus could promote the occurrence of gingival recession, whereas the comparable degree of proclination in subjects with thick alveolus could be harmless.

Numerous studies confirmed an association between morphology of the alveolar process of the mandible and facial vertical proportions (10–16). Overall, in subjects with a long facial type (also known as hyperdivergent or high-angle), the symphysis is slender and high and the alveolar bone is thin. In contrast, subjects with a short facial type (also known as hypodivergent or low-angle) have shorter symphysis and thicker alveolar bone. If an incisor in a person with long facial type, hence narrow and high mandibular symphysis, is proclined it may lead to progressive bone loss of alveolar cortical plates (17). As a result gingival recession can develop.

The objective of this study is to test a research hypothesis that facial type is associated with the development of gingival recession in a cohort of patients in whom mandibular incisors were proclined during orthodontic treatment.

Material and methods

This was a retrospective cohort study comprising orthodontic patients followed from the start of treatment (T_S) until 5 years (T_5) after completion of orthodontic therapy.

Subjects

The cohort was selected from the post-treatment archive at the Department of Orthodontics and Craniofacial Biology, Radboud University Nijmegen Medical Center, Nijmegen, the Netherlands, based on the following inclusion criteria: (1) from 11 to 14 years of age at start of orthodontic treatment (T_S), (2) all mandibular incisors were fully erupted before treatment, (3) none of incisors was extracted during treatment, (4) a fixed canine-to-canine retainer was attached directly after active orthodontic treatment with full fixed appliances, (5) no visible wear of incisal edges, (6) no orthodontic retreatment, and (7) dental casts and lateral cephalometric radiographs available before treatment (T_S), immediately after treatment (T_0), and 5 years later (T_5). Exclusion criteria were: (1) combined orthodontic/surgical treatment, (2) restorative treatment of mandibular incisors after orthodontic therapy, (3) dental casts of poor quality, particularly in the area of gingival margin, and (4) cephalograms of poor quality.

Demographic data such as gender and age during observation (at T_S, T_0, and T_5) were obtained from patient files. All subjects were treated with fixed appliances in both dental arches but the type of appliance (i.e. slot size, manufacturer, etc.) or wire sequence used could not be determined. Study size analysis was not performed before the investigation. Instead, all eligible subjects were included in the study.

Methods

Two types of orthodontic records—lateral cephalometric radiographs and dental casts—were evaluated. Lateral cephalograms were used to establish (1) facial type and (2) mandibular incisor inclination relative to mandibular plane, while dental casts were used to assess (3) the change of clinical crown heights and (4) the presence of gingival recession.

Overall, three facial types (short, average, and long face) are identified in orthodontic patients. This is usually done based on the inclination of mandibular plane angle relative to cranial base or based on the proportion of posterior facial height (PFH) to anterior facial height (AFH). To this effect, the following landmarks were identified and traced on pre-treatment (i.e. taken at T_S) lateral cephalogram: 'sella' (S, the center of sella turcica), 'nasion' (N, external point of the junction between nasal and frontal bones), 'menton' (Me, the lowest point of the mandibular symphysis), 'gonion' (Go, the most inferior posterior point of the mandibular angle), 'edge' (L1e, incisal edge of the mandibular incisor), and 'apex' (L1a, apex of the mandibular incisor). The 'inclination of the mandibular plane relative to cranial base' [Sella-Nasion/Mandibular Plane (SN/MP)] was determined as the angle between the line connecting *S* and *N* and the line connecting Me and Go landmarks; the 'proportion of posterior to anterior facial heights was determined as the proportion of distances between S and Go (PFH) and between N and Me (AFH) $\left(\frac{sella - gonion}{nasion - menton} \times 100\%\right)$. The inclination of the mandibular incisor relative mandibular plane was measured as the angle between the line connecting *L1e* and *L1a* landmarks and the line connecting Me and Go landmarks.

The 'clinical crown heights' were determined as the distances between the incisal edges and the deepest points of the curvature of the vestibulo-gingival margins. The clinical crown heights were measured on the plaster models made at pre-treatment, at the end of treatment, and 5 years later (at T_S, T_0, and T_5, respectively) for all mandibular incisors. The measurements were made with a digital caliper (Digital 6, Mauser, Winterthur, Switzerland) with an accuracy of 0.01 mm.

The presence of gingival recession before treatment, at the end of treatment, and 5 years post-treatment (at T_S, T_0, and T_5, respectively) was scored as 'Yes/No' on the plaster models. A recession was scored 'Yes' if the labial cemento-enamel junction was exposed. The methods of measurements on dental casts were described and validated in our previous study (8).

Statistical analysis and method error assessment

Descriptive statistics (means and standard deviations) were calculated. Paired *t*-tests were used to assess the change of clinical crown heights after treatment (from T_0 to T_5). Pearson product–moment correlation coefficients were calculated to analyse dependence between the SN/MP and proportion of facial heights, and between the SN/MP and mandibular incisor inclination. Regression analysis was performed to demonstrate the effects of pre-treatment (T_S) age, gender, SN/MP, and mandibular incisor inclination (independent variables) on the change of clinical crown heights from T_0 to T_5 (dependent variable) and on the occurrence of gingival recessions from T_0 to T_5 (dependent variable) in mandibular incisors.

To verify the reliability of determination of facial type, 25 cephalograms were selected at random, retraced, and remeasured. The bias was assessed with Bland-Altman plots (Figure 1). The method error for measurements of incisor inclination, clinical crown heights, and scoring recessions was reported in our previous study (8). In general, the error was small. For example, the error during clinical crown heights determination was as follows: all coefficients of reliability were greater than 0.970, the duplicate measurement error ranged from 0.07 to 0.17 mm, the systematic error (found for some measurements) was less than 0.04 mm. The kappa (K) statistics used

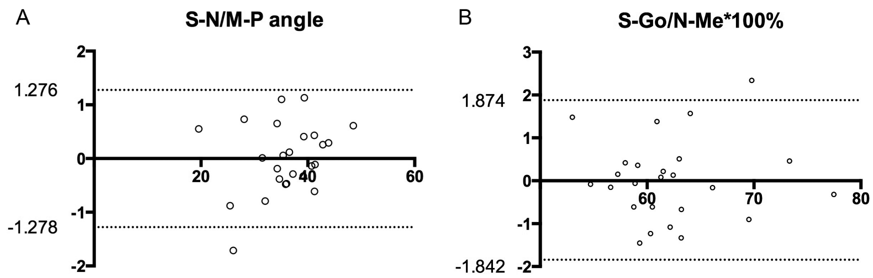

Figure 1. Bland–Altman plots demonstrating the bias for cephalometric variables: (a) S-N/M-P angle and (b) S-Go/N-Me × 100% proportion.

for the determination of observer agreement during scoring of recessions ($K > 0.850$) suggested almost perfect concordance.

Results

Cohort characteristics

One hundred and seventy-seven patients (76 males and 101 females) with a mean age before orthodontic treatment (T_S) of 12.4 years (SD = 0.8) fulfilled the inclusion criteria and were admitted to the study (Table 1). All of them had Class I or Class II malocclusion and were treated with fixed orthodontic appliances for a mean period of 2.8 years (SD = 0.8). Following a removal of orthodontic appliance at T_0, each patient had a fixed retainer bonded to mandibular six anterior teeth (canine to canine), which remained *in situ* for the whole observation period (from T_0 to T_5) of 5.5 years.

Cephalometric evaluation

The mean SN/MP in the cohort was 35.3^0 (SD = 5.8^0). This was slightly more with the normative value of SN/MP for Dutch population, which is 33^0 (SD = 3.3^0) (18). A larger standard deviation in our cohort in comparison with the sample described by Prahl-Andersen *et al*. suggested that patients with high facial types were more prevalent in the current group than in a Dutch population. The mean proportion of facial heights was 67.2 per cent (SD = 5.2; range from 52.2 to 77.3) and was highly correlated with the SN/MP angle (correlation coefficient = −0.95).

The initial (T_S) inclination of mandibular incisors was invertly correlated with the SN/MP (correlation coefficient = −0.46). It means that the incisor inclination before treatment was larger in subjects with short facial type than in subjects with long facial type. The mandibular incisor inclination increased during orthodontic treatment by 4.9^0 and remained largely unchanged for the next 5 years (T_0 to T_5). Despite the moderate correlation between the initial incisor inclination and SN/MP, the change of inclination of mandibular incisors during treatment was weakly correlated with the SN/MP angle (correlation coefficient = −0.11). It suggests that the facial type (SN/MP angle) explained only 1.2 per cent of variance of the change of mandibular incisor inclination during orthodontic treatment.

Casts evaluation

During a 5 year post-treatment period (T_0 to T_5), the number of subjects with recessions increased from 2 (1.1 per cent) to 24 (13.6 per cent), and the number of recession sites increased from 2 to 39 (Table 2). Most patients had either one or two recessions sites, and only four subjects had more than two recession sites. The mean clinical crown height of mandibular incisors increased by 0.86 mm (SD = 0.82, $P < 0.001$); Table 3. Regression models showed that mandibular plane inclination had no effect on the development of gingival recession sites (Table 4) or on the increase of clinical crown heights of mandibular incisors (Table 5) when pre-treatment age, gender, initial crown height, and post-treatment incisor inclination were controlled.

Discussion

Facial type and recession

In this study, we tested a hypothesis that the development of gingival recession in incisor region of the mandible is associated with a facial type determined by the mandibular plane inclination. The inclination of mandibular plane is an important factor affecting the planning of orthodontic treatment. It was shown that subjects with steep mandibular plane (i.e. long facial type) could have different growth characteristics (19) or therapeutical response (20, 21) than subjects with flat mandibular plane (i.e. short facial type). Importantly, a steep mandibular plane is frequently associated with slender alveolar process, while flat mandibular plane is often related with thick alveolar process and prominent bony chin (10). We hypothesized that if mandibular incisors are proclined during orthodontic treatment in a patient with steep mandibular plane, it could lead to thinning of labial aspect of the alveolus and could result in the development of gingival recession. This was demonstrated in a group of patients with mandibular overgrowth in whom mandibular incisor proclination was a part of orthodontic preparation before orthognathic surgery (22). In these subjects, mandibular plane is frequently steep and lower PFH is excessive (23). Compensatory mechanisms cause that the mandibular symphysis elongates and is narrow, incisors are retroclined, and alveolar bone is thinner than in other types of malocclusions. In such environment, orthodontic decompensation of the teeth performed before surgical correction of malocclusion can lead to further thinning of alveolar bone, dehiscence formation, and gingival recession (22, 24). In contrast, our findings showed that in a cohort of non-surgical patients with Class I and Class II malocclusion the development of gingival recession or the increase of clinical crown heights of mandibular incisors were not dependent on the mandibular plane angle (i.e. facial type). We found that both periodontal parameters demonstrated the lack of association with the facial type when mandibular incisor inclination, age, and gender were controlled for. In other words, high-angle patients in whom mandibular incisors were proclined during orthodontic treatment have the same chance of the development of gingival recession as low-angle-patients in whom incisors were not proclined.

Facial type and incisor inclination

The facial type is related with inclination of mandibular incisors—the steeper the mandibular plane, the smaller the angle between the axis of mandibular incisors and mandibular plane and *vice versa*—the

Table 1. Characteristics of the sample (N = 177).

Variable	Mean	SD	Minimum	Maximum
Age at T_S (years)	12.4	0.8	11	13.9
Age at T_0 (years)	15.2	1.1	12.5	18.3
Age at T_5 (years)	20.7	1.2	18.2	24.2
Duration of treatment (T_S to T_0) (years)	2.8	0.8	1.1	5.5
Post-treatment period (T_0 to T_5) (years)	5.5	0.6	3.2	7.3
Mandibular plane angle (SN/MP) at Ts (degrees)	35.3	5.8	19.6	48.8
Vertical facial proportion (S-Go/N-Me × 100%) (%)	62.7	5.2	52.2	77.3
Mandibular incisor inclination at Ts (degrees)	93.2	7.2	68	117.8
Mandibular incisor inclination at T_0 (degrees)	98.1	6.8	73.5	125.8
Mandibular incisor inclination at T_5 (degrees)	99	7.2	74.5	119.2

SD, standard deviation.

Table 2. Gingival recessions in the region of lower incisors pre-treatment (T_S), at the end of treatment (T_0), and 5 years (T_5) after treatment.

	Recessions		
Subjects	T_S	T_0	T_5
N without recessions	177	175	153
N with recessions	0	2	24
% with recessions	0	1.1	13.6
N with one recession	—	2	13
N with two recessions	—	—	8
N with three recessions	—	—	2
N with four recessions	—	—	1
N with five and more recessions	—	—	—
Total number of recessions	0	2	39

Table 3. The increase (in millimetres) of mean clinical crown height of lower incisors after treatment (from T_0 to T_5) assessed with paired t-tests.

Tooth number	Increase of crown height	P value
32	1.02 (0.84)	<0.001
31	0.73 (0.82)	<0.001
41	0.74 (0.84)	<0.001
42	0.95 (0.73)	<0.001
Mean	0.86 (0.82)	<0.001

Standard deviation in the brackets.

flatter the mandibular plane, the more retroclined the lower incisors (25–27). The correlation coefficients between inclination of mandibular plane and inclination of lower incisors found in populations from Sweden (25), Poland (26), and Switzerland (27) ranged from −0.44 (mean for both genders; age 7–12 years), to −0.38 (mean for both genders; age: 10 years), to −0.33 (boys, age: 13 years), to −0.27 (girls, age: 13 years), respectively. The negative correlation coefficient found in this study (−0.46) had a slightly higher absolute value than the values obtained by other authors. The difference can be explained by a possible overrepresentation of subjects with long face heights in the current sample. As mentioned earlier, the mean value of inclination of mandibular plane relative to Sella—Nasion line was higher in the present sample than the normative value for a Dutch population at the comparable age. Despite the substantial correlation between pre-treatment inclination of the mandibular plane and mandibular incisors, the amount of proclination of incisors during treatment (i.e. the change of inclination of incisors as a result of orthodontic mechanotherapy) was in fact unrelated with the facial type. It demonstrates that mandibular incisors in patients with steep, normal, and flat mandibular plane angle were proclined to a comparable degree. As a result, the reaction of periodontal tissues in patients with steep mandibular plane (i.e. long face), who likely had a thinner alveolar bone than patients with flat mandibular plane (i.e. short face), should have been comparable as in patients with other configurations of mandibular plane.

Length of follow-up

In the present investigation, we analysed the periodontal condition 5 years after orthodontic treatment. The length of observation period was dictated by the system of follow-up introduced at the Department of Orthodontics and Craniofacial Biology, Radboud University Nijmegen, in 1970s. According to the system, patients were recalled 2, 5, and 10 years after completion of treatment. It is well known, however, that the longer the time between the end of treatment and the moment of a recall appointment, the higher the drop-out rate. Årtun and Krogstad (24) stated that the development of gingival recession took place during or shortly after orthodontic treatment. Thus a 5 year follow-up was assumed to be a sensible compromise between the possibility to accumulate large sample with the minimum drop-out rate and the time needed to observe the effect of examined variable (here—the facial type) on the development of gingival recession and the increase of clinical crown height. We confirmed that this assumption held true in the other study (2), in which we found a statistically significant difference in the prevalence of gingival recession between orthodontic patients and untreated orthodontically controls already at 18 years of age. Nevertheless the issue of optimal, i.e. neither too short nor too long, follow-up period has not been resolved. Theoretically, if the development of gingival recession is influenced mainly by factor(s) present during orthodontic treatment, the follow-up period should not be too long because the natural, i.e. unrelated with orthodontic therapy, development of gingival recession can mask the gingival recession promoted by orthodontic mechanotherapy. On the other hand, it is possible that orthodontic treatment along with retention phase creates a changed environment (e.g. thinning of the labial plate of alveolar bone) during the treatment, which induces or accelerates the occurrence of gingival recession 'afterwards'. In such a situation the follow-up should be extended. So the choice of the length of observation period can depend on the research question tested in a study.

Limitations

This is a retrospective study and can have limitations related to selection bias. Selection bias occurs when study participants are

Table 4. Regression model demonstrating the effects of age, gender, mandibular plane angle, and mandibular incisor inclination on occurrence of gingival recession in the mandibular incisor region.

Increase of the number of recessions from T_0 to T_5	Independent variables	*P* value	OR	95% CI
Overall (teeth numbers 32, 31, 41, and 42)	Age at T_5	0.186	1.435	0.841 to 2.448
	Gender ($F = 0$; $M = 1$)	0.619	1.260	0.507 to 3.129
	MP/SN	0.970	0.998	0.916 to 1.088
	Incisor inclination	0.443	0.973	0.906 to 1.044

OR, odds ratio; CI, confidence interval; T_0, before treatment; F, females; M, males; MP/SN, mandibular plane angle.

Table 5. Regression models demonstrating the effects of age, gender, mandibular plane angle, and mandibular incisor inclination on increase of the clinical crown height of mandibular incisors.

Increase of the clinical crown height from T_0 to T_5	Independent variables	*P* value	OR	95% CI
Tooth number 42	Age at T_5	0.215	−7.912	−20.460 to 4.635
	Crown height at T_0	**<0.001**	0.729	0.622 to 0.837
	Gender ($F = 0$; $M = 1$)	0.065	−19.979	−41.227 to 1.269
	MP/SN	0.503	−0.681	−2.684 to 1.323
	Incisor inclination	0.155	−0.127	−0.304 to 0.049
Tooth number 41	Age at T_5	0.848	1.491	−13.814 to 16.796
	Crown height at T_0	**<0.001**	0.892	0.758 to 1.026
	Gender ($F = 0$; $M = 1$)	0.340	12.767	−13.556 to 39.090
	MP/SN	0.693	0.496	−1.981 to 2.972
	Incisor inclination	0.263	−0.123	−0.340 to 0.094
Tooth number 31	Age at T_5	0.410	6.236	−8.0662 to 21.134
	Crown height at T_0	**<0.001**	0.851	0.720 to 0.983
	Gender ($F = 0$; $M = 1$)	0.692	5.170	−20.518 to 30.858
	MP/SN	0.326	1.206	−1.212 to 3.625
	Incisor inclination	0.752	−0.034	−0.247 to 0.179
Tooth number 32	Age at T_5	0.954	−0.407	−14.229 to 13.484
	Crown height at T_0	**<0.001**	0.663	0.545 to 0.782
	Gender ($F = 0$; $M = 1$)	**0.013**	−30.267	−53.943 to −6.591
	MP/SN	0.132	−1.709	−3.941 to 0.523
	Incisor inclination	0.514	−0.067	−0.268 to 0.135
Overall (teeth numbers 32, 31, 41, and 42)	Age at T_5	0.818	−1.416	−13.518 to 10.685
	Crown height at T_0	**<0.001**	0.842	0.727 to 0.957
	Gender ($F = 0$; $M = 1$)	0.447	−7.985	−28.680 to 12.709
	MP/SN	0.834	−0.207	−2.156 to 1.742
	Incisor Inclination	0.452	−0.066	−0.238 to 0.106

OR, odds ratio; CI, confidence interval; F, females; M, males; MP/SN, mandibular plane angle. Bold values denote statistical significance.

systematically different from eligible but not included participants. It cannot be ruled out that the prevalence or distribution of gingival recession in patients attending 5 year post-treatment recall visit and selected for this study was different than in a population of orthodontic patients at large. However, the large sample size and inclusion of consecutively treated patients should have reduced a potential for selection bias. Furthermore, we evaluated here if the mandibular plane inclination (i.e. facial type) is related with the development of gingival recession. We based our hypothesis on numerous studies showing that the inclination of the mandibular plane is related with thickness of the alveolar bone. However, we did not make direct measurements of the alveolus and it is possible that some of them might be related with deterioration of periodontal condition. However, for a clinician, an establishment of a relationship between the facial type and gingival recession is sensible because the determination of facial type is easy and routinely performed and had it been associated with gingival recession it could have had a significant prognostic value.

In conclusion, the inclination of the mandibular plane relative to cranial base is not associated with the development of gingival recession. Therefore it cannot be used as a risk factor for occurrence of gingival recession.

Acknowledgements

We would like to thank Dr Ewald Bronkhorst from Radboud University Medical Centre, Nijmegen, the Netherlands, for statistical analysis.

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